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(54) Apparatus for fabricating apodized fiber grating

(57) There is provided an apparatus for fabricating an apodized fiber grating. In the apodized fiber grating fabricating apparatus, a UV (Ultra Violet) laser emits a UV laser beam, a beam splitter splits the UV laser beam emitted from the UV laser into two beams, a plurality of mirrors form light paths to concurrently project the split beams onto an optical fiber from two directions by reflecting the split beams, a phase mask passes the reflected beams therethrough in such a way to form gratings in the optical fiber in a predetermined period, a first blocking device is disposed between the phase mask and one of the mirrors, progressively blocks one of the two beams from being projected toward the optical fiber from one direction, and provides apodization to the formed gratings, and a second blocking device, which is mobile and opposite to the first blocking device with respect to the optical fiber, progressively blocks the other beam from being projected toward the optical fiber from another direction and provides apodization to the formed gratings, so that an average refractive index variation is constant across the whole gratings.

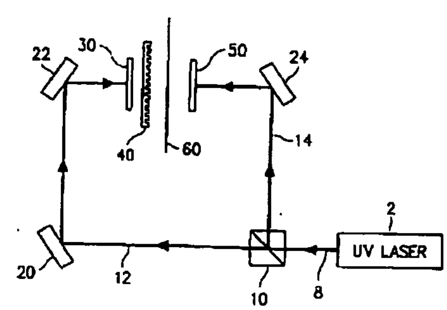

FIG. 3

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates generally to fiber gratings, and in particular, to an apparatus for fabricating apodized fiber gratings.

2. Description of the Related Art

[0002] Along with an increase in the data transmission capacity of a WDM (Wavelength Division Multiplexing) system, channel spacing gets narrower. Therefore, there is an increasing need for an optical filter that has a narrow bandwidth and an excellent adjacent channel isolation characteristic.

[0003] Fiber gratings satisfy the requirements of the optical filter, i.e., low loss, low polarization dependence, and high channel selectivity. Further, the cost effectiveness of the fiber gratings make them popular as an optical filter.

[0004] However, when a general fiber grating is fabricated in a conventional method using an excimer laser and a uniform phase mask, its refractive index varies on the whole as shown in FIG. 1.

[0005] As indicated by a one-dot-dashed line (a) in FIG. 11, sidelobe occurs and as a result, no apodization is achieved at the fiber grating.

[0006] This sidelobe can be reduced by apodizing the fiber grating such that the magnitude of a refractive index variation is decreased toward the ends of the fiber grating. Another one-dot-dashed line (b) in FIG. 11 indicates a variation in the refractive index of the apodized fiber grating.

[0007] An apodized fiber grating refers to a fiber grating of which the refractive index increases or decreases toward the center or both ends. The apodized fiber grating shows minimized sidelobes in both a short wavelength band and a long wavelength band.

[0008] Although apodization is effective in reducing sidelobe in a longer wavelength band, it has limitations in reducing sidelobe in a shorter wavelength band due to self-induced chirping of a fiber grating.

[0009] The self-induced chirping is attributed to an inconstant average refractive index of the fiber grating as shown in FIG. 2. Accordingly, the average refractive index should be made constant with respect to grating length in order to reduce sidelobe which arises from the self-induced chirping.

[0010] Other conventional fiber grating apodizing methods besides the conventional method shown in FIG. 2 include overlap writing, use of a PTZ (Piezo Transducer), optical scanning, and use of a spatial filter.

[0011] The overlap writing method is called an interference method, in which apodization is achieved by writing gratings superimposed on other gratings of different periods and sizes in an optical fiber.

[0012] As another conventional apodization method, gratings are written on an optical fiber while a tensile force is applied to the optical fiber using a PZT. During writing the gratings, the optical fiber or a phase mask is vibrated for a desired length in the length direction of the optical fiber by the use of the PZT.

[0013] Thirdly, apodized gratings are written by scanning an optical fiber covered with a phase mask with UV (Ultra Violet) light lengthwise with different light intensities at different scanning rates.

[0014] A spatial filter operates based on light interference. In this method, the intensity of interference light passed through a diffraction slit exhibits a Gaussian distribution. A spatial filter with a different transmission is disposed before a phase mask along the length direction of an optical fiber and UV light is projected onto the phase mask.

[0015] The above conventional apodized fiber grating fabricating methods have the following problems:

(1) The overlap writing: a device for accurately controlling a length smaller than a grating period is required for appropriate overlapped writing, thereby making it complicated to fabricate fiber gratings;
(2) The use of a PZT: it is also difficult to control a length smaller than a grating period reliably;
(3) The optical scanning: an optical scanning rate and optical intensity should be controlled appropriately to obtain a desired apodized grating; and
(4) The use of a spatial filter: vibrations should be blocked since gratings are fabricated using interference patterns and for this purpose, an expensive device is required.

[0016] Especially, when a fiber grating is fabricated using a phase mask, the phase mask should be fabricated by focused ion beam implantation and wet etching to have an effective profile. A new phase mask is needed at every change in apodization conditions. Therefore, this method is not effective in terms of cost and flexibility.

[0017] Despite the advantage of production of gratings with various characteristics, the method of scanning an optical fiber lengthwise with UV light at a controlled light intensity has the distinctive shortcomings of long fabrication time and bad reproducibility.

[0018] Consequently, the apodizing phase mask using method is not effective in terms of cost and flexibility since a phase mask is difficult to fabricate and a new phase mask is needed at every change in apodization conditions. Moreover, the beam scanning method has the disadvantages of difficult fabrication, long fabrication time, and bad reproducibility.

SUMMARY OF THE INVENTION

[0019] It is, therefore, an object of the present

invention to provide an apparatus for fabricating an apodized fiber grating readily using a beam splitter and a screen mask.

[0020] It is another object of the present invention to provide an apparatus for fabricating an apodized fiber grating with a uniform refractive index distribution in the length direction.

[0021] To achieve the above objects, in an apodized fiber grating fabricating apparatus according one aspect of the present invention, a UV (Ultra Violet) laser emits a UV laser beam, a beam splitter splits the UV laser beam emitted from the UV laser into two beams, a plurality of mirrors form light paths to concurrently project the split beams onto an optical fiber from two directions by reflecting the split beams, a phase mask passes the reflected beams therethrough in such a way to form gratings in the optical fiber in a predetermined period, a first blocking device is disposed between the phase mask and one of the mirrors, progressively blocks one of the two beams from being projected toward the optical fiber from one direction, and provides apodization to the formed gratings, and a second blocking device, which is mobile and opposite to the first blocking device with respect to the optical fiber, progressively blocks the other beam from being projected toward the optical fiber from another direction and provides apodization to the formed gratings, so that an average refractive index variation is constant across the whole gratings.

[0022] In an apodized fiber grating fabricating apparatus according to another aspect of the present invention, a first UV laser emits a first UV laser beam toward an optical fiber from one direction and a second UV laser emits a second UV laser beam toward the optical fiber from an opposite direction. A phase mask forms gratings in the optical fiber in a predetermined period by reinforcement and interference of the first UV laser beam. A first blocking device, disposed between the first UV laser and the phase mask, progressively blocks one of the beams from being projected to the optical fiber and thus provides apodization to the formed gratings, and a second blocking device opposite to the first blocking device with respect to the optical fiber, progressively blocks the other beam from being projected to the optical fiber and provides apodization to the formed gratings, so that an average refractive index variation is constant across the whole gratings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a graph showing the variation of a refractive index in the length direction of a general fiber grating fabricated using a uniform phase mask in a conventional method;

FIG. 2 is a graph showing the variation of a refractive index in the length direction of an apodized fiber grating fabricated in another conventional method;

FIG. 3 is a schematic view of an apodized fiber grating fabricating apparatus according to a preferred embodiment of the present invention;

FIG. 4 is a schematic view of an apodized fiber grating fabricating apparatus according to another preferred embodiment of the present invention;

FIG. 5A illustrates the operation of a first screen mask when t = 0;

FIG. 5B illustrates the operation of a second screen mask when t = 0;

FIG. 6A illustrates the operation of the first screen mask when $t = t_1$;

FIG. 6B illustrates the operation of the second screen mask when $t = t_1$;

FIG. 7A illustrates the operation of the first screen mask when $t = t_2$;

FIG. 7B illustrates the operation of the second screen mask when $t = t_2$;

FIG. 8 is a graph showing the variation of a refractive index in the length direction of an apodized fiber grating fabricated using the first screen mask according to the present invention;

FIG. 9 is a graph showing the variation of refractive index in the length direction of an apodized fiber grating fabricated using the second screen mask according to the present invention;

FIG. 10 is a graph showing the variation of a refractive index in the length direction of an apodized fiber grating fabricated by concurrently shifting the first and the second screen masks according to the present invention; and

FIG. 11 illustrates the reflective spectrums of fiber gratings with respect to the refractive index variations shown in FIGs. 1, 2, and 9.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] Preferred embodiments of the present invention will be described hereinbelow with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

[0025] FIG. 3 schematically illustrates the configuration of an apodized fiber grating fabricating apparatus according to a preferred embodiment of the present invention.

[0026] In FIG. 3, the apodized optical fiber grating fabricating apparatus includes a UV laser 2 as a light source, a beam splitter 10 for splitting a beam 8 emitted from the UV laser 2, a plurality of mirrors 20, 22, and 24 for controlling the direction of beams projected from the beam splitter 10, first and second mobile screen masks

30 and 50 to be used for apodizing a grating when the beams reflected from the mirrors 20, 22, and 24 are projected onto an optical fiber 60, and a phase mask 40 for generating the grating by interference and reinforcement of the projected light.

[0027] The beam splitter 10 splits the beam 8 emitted from the UV laser 2 into two beams 12 and 14. One 12 of the beams is reflected from the mirrors 20 and 22 and reaches the first screen mask 30 and the other beam 14 is reflected from the mirror 24 and reaches the second screen mask 50. The two beams 12 and 14 travel mutually orthogonally from the beam splitter 10. The beam 12 is sequentially reflected from the first and second mirrors 20 and 22 and impinges on the phase mask 40. The first mask 30 and second mask 50 are disposed face to face at both sides of the optical fiber 60. The phase mask 40 is interposed between the first screen mask 30 and the optical fiber 60.

[0028] The beam 12 is projected onto the phase mask 40 and forms a plurality of gratings in the optical fiber 60 in a predetermined period by reinforcement and interference of light as the beam 12 passes through the phase mask 40. The beam 14 is reflected from the third mirror 24 and reaches the second screen mask 50. Consequently, the beam 8 emitted from the UV laser 2 is concurrently projected onto the first and second screen masks 30 and 50 through the beam splitter 10 and the mirrors 20, 22, and 24.

[0029] The first and second screen masks 30 and 50 are mobile for apodization of the gratings according to the present invention.

[0030] FIG. 4 is a schematic view of an apodized fiber grating fabricating apparatus according to another preferred embodiment of the present invention. While the apodized fiber grating fabricating apparatus of FIG. 3 projects a beam from a UV laser onto an optical fiber in two directions using a beam splitter and a plurality of mirrors, the one shown in FIG. 4 projects a beam onto an optical fiber in two directions using two UV lasers.

[0031] Referring to FIG. 4, the apodized fiber grating fabricating apparatus according to the second embodiment of the present invention includes a first UV laser 4 disposed at one side of the optical fiber 60, a second UV laser 6 disposed at the other side of the optical fiber 60, the phase mask 40 through which a beam 16 emitted from the first UV laser 4 passes to write a grating in the optical fiber 60 utilizing light reinforcement and interference, the first screen mask 30 over the phase mask 40 to apodize the fiber grating, and the second screen mask 50 between the second UV laser 6 and the optical fiber 60 to apodize the optical fiber grating. The first and second screen masks 30 and 50 face each other a predetermined distance apart with the interposition of the optical fiber 60. Also, the first and second screen masks 30 and 50 are mobile for apodization of the written grating. The beam 16 emitted from the first UV laser 4 is projected onto the phase mask 40 and forms gratings in the optical fiber 60 in a predetermined period by light reinforcement and interference as it passes through the phase mask 40. The first and second screen masks 30 and 50 apodize the fabricated gratings as they are approaching each other.

[0032] The configurations and operations of the first and second screen masks 30 and 50 will be described hereinbelow. It is first to be noted that the first and second screen masks 30 and 50 act to block beams and may be formed of any material as far as it can block the travel of beams.

[0033] According to the present invention, beams 16 and 18 induced through a plurality of mirrors impinge on the optical fiber 60 from two directions. As the beams 16 and 18 pass through the phase mask 40, they form gratings in the optical fiber 60. Then, the beams 16 and 18 apodize the gratings through the first and second screen masks 30 and 50 while the first and second screen masks 30 and 50 transfer beams with a Gaussian profile to the phase mask 40, moving over a predetermined time.

[0034] Referring to FIGs. 5A to 7B, the configuration and operation of the mobile first and second screen masks 30 and 50 will be described in detail. FIGs. 5A and 5B illustrate the operations of the first and second screen masks 30 and 50, respectively when time $t = 0$. FIGs. 6A and 6B illustrate the operations of the first and second screen masks 30 and 50, respectively when $t = t_1$. FIGs. 7A and 7B illustrate the operations of the first and second screen masks 30 and 50, respectively when $t = t_2$.

[0035] In the drawings, an X axis represents the movement direction of the first and second screen masks 30 and 50 and a Z axis, the length direction of the optical fiber 60. Reference symbol ⇑ also indicates the movement direction of the first and second screen masks 30 and 50. Reference character L indicates a length of the optical fiber 60 for which gratings are written, reference character B indicates the mid point of L, and reference characters A and C indicate both ends of L.

[0036] The first screen mask 30 includes a concave portion 30a at the center and convex portions 30b that are protruded gradually from the concave portion 30a towards both ends of the first screen mask 30. The second screen mask 50 includes a convex portion 50a at the center and concave portions 50b that are sunken gradually from the center towards both ends of the second screen mask 50. The configurations of the first and second screen masks 30 and 50 in FIGs. 5A to 7B are merely exemplary applications, and it is clear that many variations can be made as far as they are used for apodization of written gratings. for example, the first and second screen masks 30 and 50 can be shaped into steps.

[0037] When $t = 0$, a first laser beam emitted from the first UV laser is all projected onto the phase mask 40 and forms a grating in the optical fiber 60 in a predetermined period through the phase mask 40, as shown in

FIG. 5A.

[0038] Referring to FIG. 6A, when $t = t_1$, i.e., the first screen mask 30 approaches the optical fiber 60 at a predetermined speed, the first screen mask 30 moves in a direction as indicated by ⇑ until it covers portions A and C of the optical fiber 60. Therefore, the portions A and C are excluded from irradiation of the first UV laser beam emitted from the first UV laser whereas a portion B of the optical fiber 60 is irradiated with the first UV laser beam for a predetermined time.

[0039] Referring to FIG. 7A, when $t = t_2$, the first screen mask 30 further moves in the direction as indicated by ⇑ until it covers all the portions A, B, and C. Hence, the first UV laser beam reaches any of the portions A, B, and C of the optical fiber 60 no longer.

[0040] As stated above, the intensity of the first laser beam is controlled by progressively covering the phase mask 40 with the first screen mask 30. As a result, a refractive index varies as shown in FIG. 8. FIG. 8 is a graph showing a variation in the refractive index with respect to the length direction of an optical fiber when gratings are formed in the optical fiber using the first screen mask. An X axis represents the variation of the refractive index and a Z axis, the length direction of the optical fiber.

[0041] An apodized fiber grating experiences a greater variation in refractive index as it is nearer to the portion B of the optical fiber. On the contrary, the refractive index is less changed as an apodized grating is formed nearer to the portion A or C.

[0042] As for the second screen mask 50, a second UV laser beam is projected onto the optical fiber 60 with a predetermined width when $t = 0$ as shown in FIG. 5B.

[0043] Referring to FIG. 6B, when $t = t_1$, the second screen mask 50 moves in a direction as indicated by ⇑ until the portion B of the optical fiber is gradually covered and excluded from irradiation of the second UV laser beam. Meanwhile, the second UV laser beam is projected onto the portions A and C of the optical fiber 60 for a predetermined time.

[0044] Referring to FIG. 7B, when $t = t_2$, the second screen mask 50 further moves in the direction as indicated by ⇑ until it covers all the portions A, B, and C and thus the second UV laser beam reaches any of the portions A, B, and C no longer.

[0045] As stated above, the intensity of the second laser beam is controlled by progressively covering the phase mask 40 with the second screen mask 50. As a result, a refractive index varies as shown in FIG. 9. FIG. 9 is a graph showing a variations in the refractive index with respect to the length direction of an optical fiber when gratings are formed in the optical fiber using the second screen mask. An X axis represents the variation of the refractive index and a Z axis, the length direction of the optical fiber.

[0046] An apodized fiber grating experiences a greater variation in refractive index as it is nearer to the portion A or C of the optical fiber. On the contrary, the refractive index is less changed as an apodized grating is formed nearer to the portion B.

[0047] FIG. 10 is a graph showing a variations in refractive index in the length direction of a fiber grating when the grating is written in an optical fiber by projecting a UV laser beam onto the optical fiber from two directions, moving the first and second screen masks 30 and 50 concurrently.

[0048] Apodization is achieved in the grating by setting an average refractive index to be constant along the length of the fiber grating as shown in FIG. 10, and sidelobes in short and long wavelength bands are minimized as shown in FIG. 11.

[0049] The characteristics of an apodized fiber grating according to the present invention will be described referring to FIG. 11. In FIG. 11, the one-dot-dashed line (a) indicates the reflective spectrum of a general optical fiber fabricated using a uniform mask as shown in FIG. 1.

[0050] Another one-dot-dashed line (b) indicates the reflective spectrum of an apodized fiber grating of which the refractive index varies as shown in FIG. 2. As noted from (b), it is difficult to minimize sidelobe in a short wavelength band.

[0051] A solid line (c) indicates the reflective spectrum of an apodized fiber grating at wavelengths according to the present invention. Sidelobes in short and long wavelength bands are reduced.

[0052] As described above, an apodized fiber grating fabricating apparatus of the present invention forms apodized fiber gratings readily using a beam splitter and screen masks in addition to an existing optical equipment and phase mask, instead of separately procuring a new apodizing phase mask at every change in apodization conditions, or the beam scanning method having the disadvantages of difficult fabrication, long fabrication time, and bad reproducibility. Further, an apodized fiber grating can be written easily by the use of two UV lasers.

[0053] The present invention has been described in the context with an apodized fiber grating fabricating apparatus having two screen masks as beam blocking means, but the number of the screen masks is not limited so long as an average refractive index variation is constant over the entire apodized fiber gratings.

[0054] While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

[0055] As described above, an apodized fiber grating fabricating apparatus of the present invention forms apodized fiber gratings readily using a beam splitter and screen masks in addition to an existing optical equipment and phase mask, instead of separately procuring a new apodizing phase mask at every change in apodi-

zation conditions, or the beam scanning method having the disadvantages of difficult fabrication, long fabrication time, and bad reproducibility.

Claims

1. An apparatus for fabricating an apodized fiber grating, comprising:

   a UV (Ultra Violet) laser for emitting a UV laser beam;
   a beam splitter for splitting the UV laser beam emitted from the UV laser into two beams;
   a plurality of mirrors for forming light paths to concurrently project the split beams onto an optical fiber from two directions by reflecting the split beams;
   a phase mask for passing the reflected beams to form gratings in the optical fiber in a predetermined period;
   a first blocking device between the phase mask and one of the mirrors, for progressively blocking one of the two beams from being projected toward the optical fiber from one direction and providing apodization to the formed gratings; and
   a second blocking device which is mobile and opposite to the first blocking device with respect to the optical fiber, for progressively blocking the other beam from being projected toward the optical fiber from another direction and providing apodization to the formed gratings, so that an average refractive index variation is constant across the whole gratings.

2. The apparatus of claim 1, wherein the first blocking device is a first screen mask.

3. The apparatus of claim 2, wherein the first screen mask includes:

   a concave portion at the center, for providing apodization to the formed gratings; and
   two convex portions gradually protruded from the concave portion toward both ends of the first screen mask.

4. The apparatus of claim 1, wherein the second blocking device is a second screen mask.

5. The apparatus of claim 4, wherein the second screen mask includes:

   a convex portion at the center; and
   two concave portions gradually sunken from the convex portion toward both ends of the second screen mask.

6. An apparatus for fabricating an apodized fiber grating, comprising:

   a first UV laser for emitting a first UV laser beam toward an optical fiber from one direction;
   a second UV laser for emitting a second UV laser beam toward the optical fiber from an opposite direction;
   a phase mask for forming gratings in the optical fiber in a predetermined period by reinforcement and interference of the first UV laser beam;
   a first blocking device between the first UV laser and the phase mask, for progressively blocking one of the beams from being projected to the optical fiber and thus providing apodization to the formed gratings; and
   a second blocking device opposite to the first blocking device with respect to the optical fiber, for progressively blocking the other beam from being projected to the optical fiber and providing apodization to the formed gratings, so that an average refractive index variation is constant across the whole gratings.

7. The apparatus of claim 6, wherein the first blocking device is a first screen mask.

8. The apparatus of claim 7, wherein the first screen mask includes:

   a concave portion at the center, for providing apodization to the formed gratings; and
   two convex portions gradually protruded from the concave portion toward both ends of the first screen mask.

9. The apparatus of claim 6, wherein the second blocking device is a second screen mask.

10. The apparatus of claim 9, wherein the second screen mask includes:

   a convex portion at the center; and
   two concave portions gradually sunken from the convex portion toward both ends of the second screen mask.

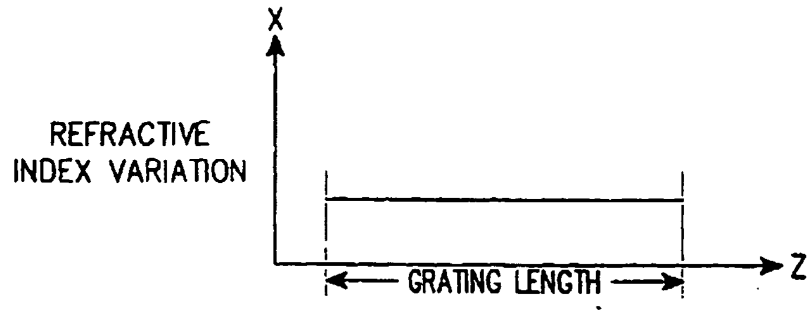

X
REFRACTIVE INDEX VARIATION
GRATING LENGTH
Z

FIG. 1

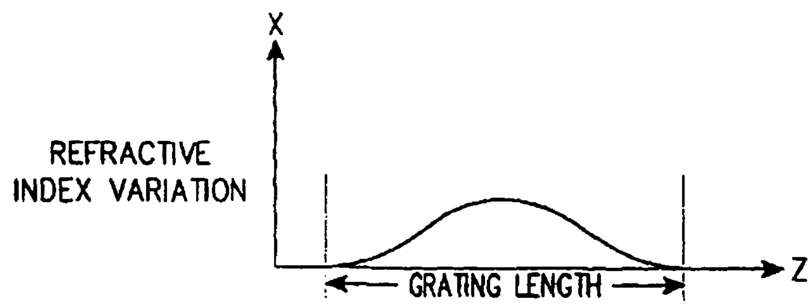

X
REFRACTIVE INDEX VARIATION
GRATING LENGTH
Z

FIG. 2

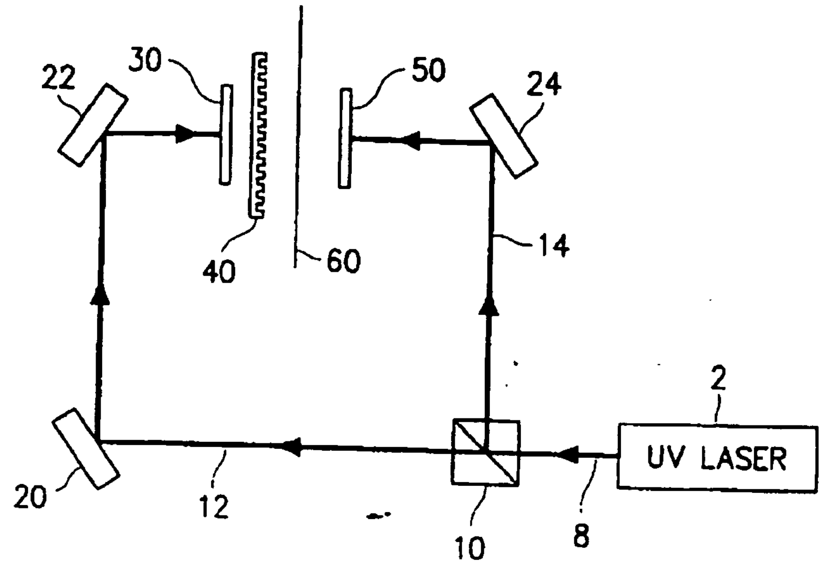

22
30
50
24
40
60
14
2
UV LASER
20
12
10
8

FIG. 3

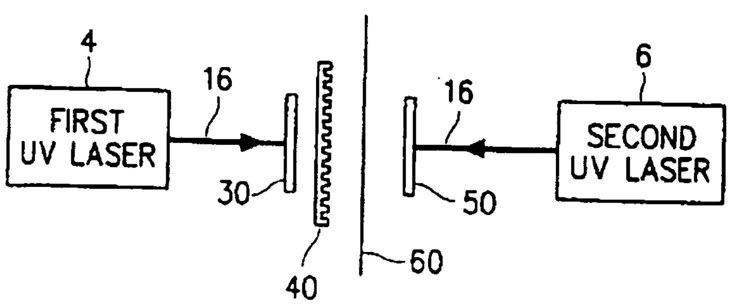

4
FIRST
UV LASER
16
16
6
SECOND
UV LASER
30
50
40
60

FIG. 4

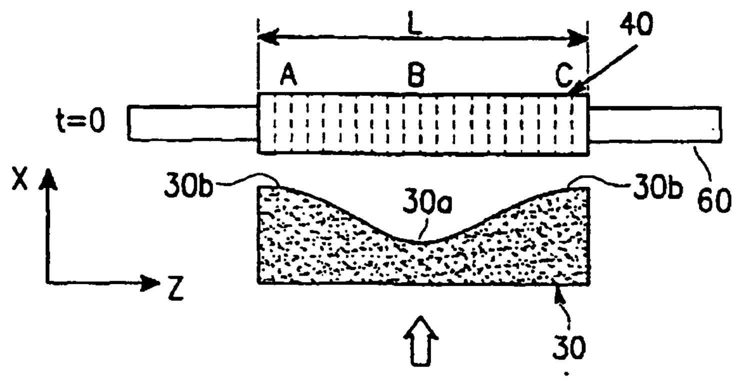


FIG. 5A

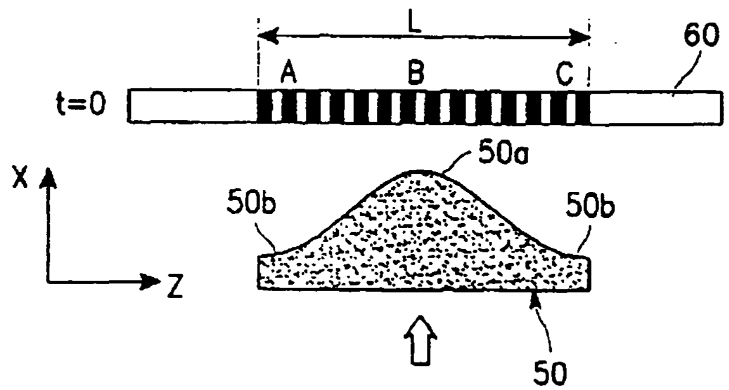


FIG. 5B

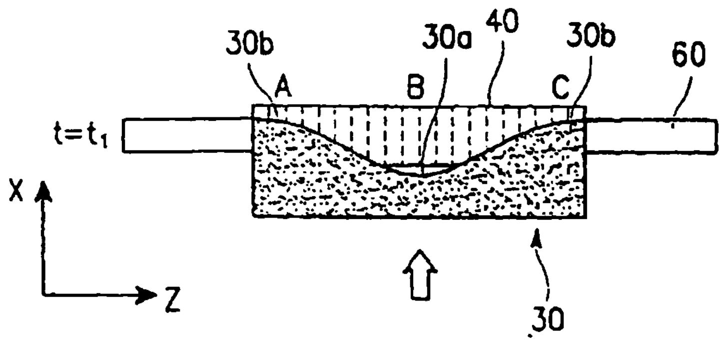


FIG. 6A

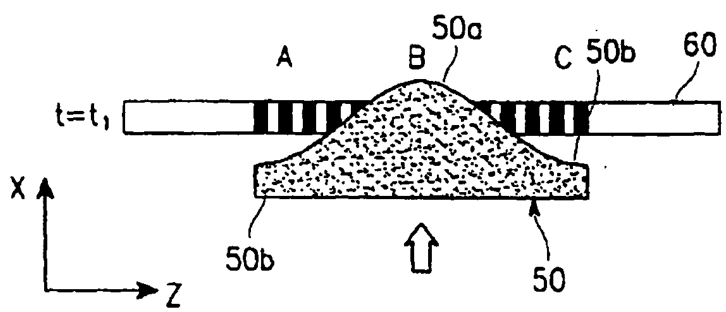


FIG. 6B

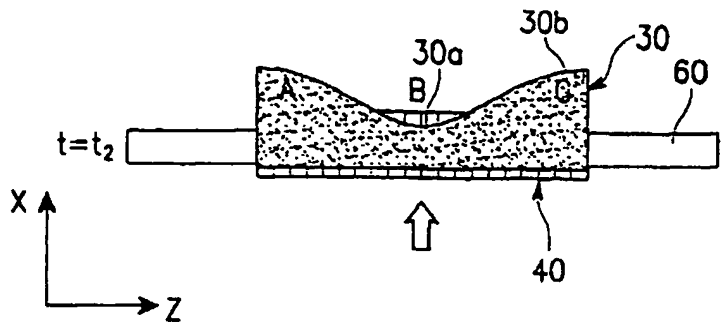


FIG. 7A

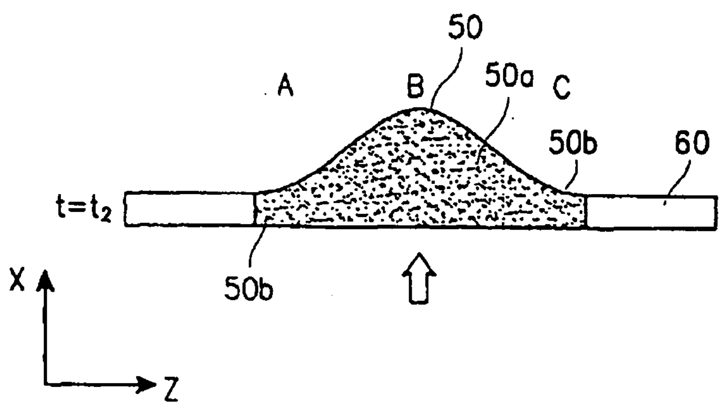


FIG. 7B

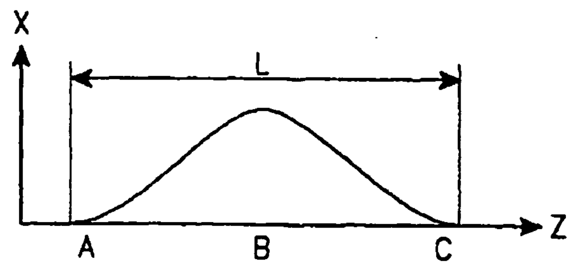


FIG. 8

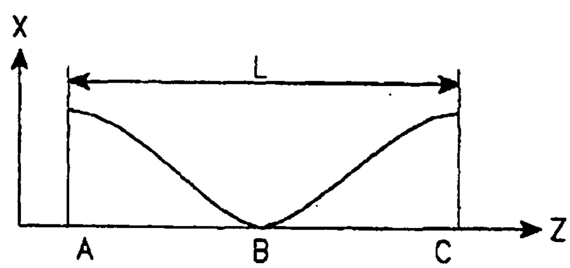


FIG. 9

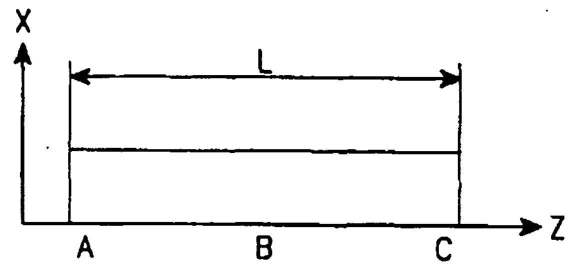
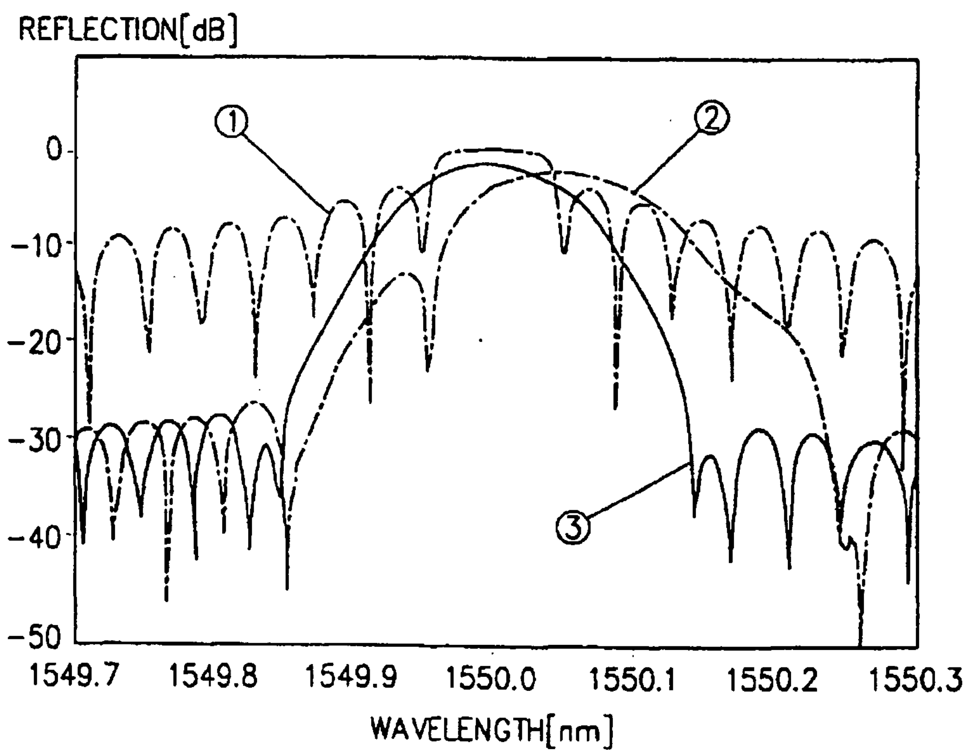

X
L
Z
A
B
C

FIG. 10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1549.8
1549.9
1550.0
1550.1
1550.2
1550.3
WAVELENGTH[nm]
①
②
③

FIG. 11

(19) Europäisches Patentamt
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Office européen des brevets

(11) EP 1 065 535 A3

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(54) **Apparatus for fabricating apodized fiber grating**

(57) In the disclosed apodized fiber grating fabricating apparatus, a UV (Ultra Violet) laser (2) emits a UV laser beam (8), a beam splitter (10) splits the beam emitted from the laser into two beams (12,14), a plurality of mirrors (20,22,24) form light paths to concurrently project the split beams onto an optical fiber (60) from two directions by reflecting the split beams, a phase mask (40) passes the reflected beams therethrough to form gratings in the fiber in a predetermined period, a first blocking device (30) is disposed between the mask and one of the mirrors, progressively blocks one of the two beams from being projected toward the fiber from one direction, and provides apodization to the gratings, and a second blocking device (50), which is mobile and opposite to the first blocking device with respect to the fiber, progressively blocks the other beam from being projected toward the fiber from another direction and provides apodization to the gratings, so that an average refractive index variation is constant across the whole gratings.

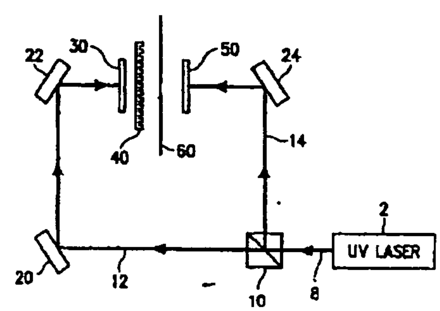

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 00 11 3502

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	SINGH H ET AL: "APODIZED FIBER BRAGG GRATINGS FOR DWDM APPLICATIONS USING UNIFORM PHASE MASK" PROCEEDINGS OF THE 24TH EUROPEAN CONFERENCE ON OPTICAL COMMUNICATION, vol. 1, 1998, pages 189-190, XP000901091 * figures 1,3 *	1-10	G02B6/16 G02B6/34
Y	US 5 652 818 A (BYRON KEVIN CHRISTOPHER) 29 July 1997 (1997-07-29) * the whole document *	1-10	
A	EP 0 884 613 A (FRANCE TELECOM) 16 December 1998 (1998-12-16) * claim 1; figures 3,4 *	1,5	
A	FROHLICH H-G ET AL: "Two methods of apodisation of fibre-Bragg-gratings" OPTICS COMMUNICATIONS, NORTH-HOLLAND PUBLISHING CO. AMSTERDAM, NL, vol. 157, no. 1-6, 1 December 1998 (1998-12-01), pages 273-281, XP004150733 ISSN: 0030-4018 * the whole document *	1,5	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	5 February 2002	Lord, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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05-02-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5652818 A	29-07-1997	GB 2302599 A	22-01-1997
EP 0884613 A	16-12-1998	FR 2764394 A1	11-12-1998
		DE 69800679 D1	17-05-2001
		DE 69800679 T2	29-11-2001
		EP 0884613 A2	16-12-1998
		US 6043497 A	28-03-2000

EPO FORM P0459

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